Capitol Graduate Research Summit

Optimizing the Thermal Performance of Phase-Change Thermal Management Systems for Utility-Scale Applications in Kansas

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Unlike the conventional cooling systems, phase-change cooling systems using wicks offer reliable high and effective heat flux cooling capability. However, the thermal performance of these novel thermal management systems which find applications in both small- (e.g., concentrated heat-dissipating microelectronics) and utility-scale (e.g., power-generating plants) systems are still limited due to some technical challenges. Our research is focused on trying to understand, fundamentally, the physics behind these limitations and addressing them. We dedicate our study towards designing, fabricating, and assessing novel cooling systems that employ sintered-particle metallic wicks and take advantage of the large latent heat of vaporization of liquid coolants such as water. The state of Kansas has numerous utility-scale systems that could benefit from the outcome of this research. For example, the power stations, including nuclear and coal powered plants, such as the Wolf Creek Generating Station and the Wester-Jeffery Energy Centre, employ conventional cooling systems that reduce fuel efficiency and increase carbon dioxide (CO2) emissions. Therefore, employing these novel cooling systems would potentially increase fuel efficiency and reduce CO2 emissions. This is very important considering the fast-depleting energy fuel reserves and the imminent danger of global warming. The food, water, chemical, and material manufacturing industries in Kansas that require either efficient, reliable, and cheap heat dissipation and/or steam generation would also benefit from the success of this work. And finally, the aerospace industry, some of which are in Kansas, is desperately in demand of this technology, and the present study could be the answer.